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AUTHOR Bart, William M.
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ABSTRACT

Elements of a theory relating cognition and affect are outlined. The theory is heavily based upon neuroscience research regarding the hemispheric lateralization of various cognitive processes and emotions; specific examples are provided. Developmental research on intelligence as well as theories of intrinsic motivation, are also discussed. Suggestions for further research are made, as further development of this theory may suggest educational applications (Author/GDC)

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Developmental and Neurological Implications for Relating Cognition and Affect

William M. Bart
University of Minnesota

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Abstract

Elements of a theory relating cognition and effect are provided. The theory draws heavily from neuroscience research regarding hemispheric lateralization of cognitive processes and somewhat from developmental research on intelligence. Testable propositions are derived and educational applications are cited.

The purpose of this paper is to describe elements of a theory relating cognition and affect. This theory draws heavily from neuroscience and cognitive developmental research findings. Although this theory is far from complete, enough is described so that empirical research can be suggested and practical consequences can be considered.

One key source of stimulation for this theory has been the view of Jean Piaget regarding the relationship of affect to cognition. Piaget's view is so basic to the theory that we will begin with a brief review of some of Piaget's ideas on cognition and affect.

Piaget on Cognition and Affect

In his book The psychology of intelligence, Jean Piaget discussed the relationships between affect and cognition. He emphasized the role of adaptation in interpreting both.

> "Every response, whether it be an act directed towards the outside world or an act internalized as thought, takes the form of an adaptation or, better, of a re-adaptation. The individual acts only if he experiences a need, i.e., if the equilibrium between the environment and the organism is momentarily upset, and action tends to re-establish the equilibrium, i.e., to re-adapt the organism (Claparede). A response is thus a particular case of interaction between the external world and the subject, but unlike physiological interactions, which are of a material nature and involve an internal change in the bodies which are present, the responses studied by psychology are of a functional nature and are achieved at greater and greater distances in space (perception, etc.) and in time (memory, etc.). Behavior, thus conceived in terms of functional interaction, presupposes two essential and closely interdependent aspects: an affective aspect and a cognitive aspect." (Piaget, 1950, p. 4).

Piaget tended to interpret affect as feelings and emotions and cognition as intelligence. Feelings designate goals for behavior and intelligence provides the

means to attain the goals. To Piaget, the affective and cognitive domains are inextricably interconnected.

> "Affective life and cognitive life, then, are inseparable although distinct. They are inseparable because all interaction with the environment involves both a structuring and a valuation, but they are none the less distinct, since these two aspects of behavior cannot be reduced to one another. Thus we could not reason, even in pure mathematics, without experiencing certain feelings, and conversely no affect can exist without a minimum of understanding or of discrimination. An act of intelligence involves, then, an internal regulation of energy (interest, effort, ease, etc.) and external regulation (the value of the solutions sought and of the objects concerned in the search), but these two controls are of an affective nature and remain comparable with all other regulations of this type. Similarly, the perceptual or intellectual elements which we find in all manifestations of emotion involved cognition in the same way as any other perceptual or intelligent reactions. What common sense calls 'feelings' and 'intelligence,' regarding them as two opposed 'faculties,' are simply behavior relating to persons and behavior affecting ideas or things; but in each of these forms of behavior, the same affective and cognitive aspects of action emerge, aspects which are in fact always associated and in no way represent independent faculties." (Piaget, 1950, p. 6)

Piaget suggests that the goals that feelings designate for behavior tend to be oriented to the adaptation of a human to his/her external (social or physical) environment. The theory to be presented emanates from a consideration of Piaget's view as to how cognition relates to affect.

<u>An Alternative Theory relating Cognition to Affect</u>.

Let me suggest that the goals that feelings designate for behavior can be internally-oriented, as well as externally-oriented as suggested by Piaget.

Feelings constitute "a language of the brain" in that feelings designate not only externally-oriented goals in behavior which permit a human to adapt to his/her external (social or physical) environment, but also internally-oriented goals in behavior which permit a human to experience certain optimal forms of brain stimulation. Feelings are positive or negative to the extent to which optimal or non-optimal forms of brain stimulation are effected in the form of the cognitive processing of some information.

It is possible to pose an externally-oriented goal for behavior which provides a positive feeling state but which leads to the usage of cognitive means which are not optimal and thus which engender a feeling state so negative so as to overcome the positive feeling resulting from the consideration of the externally-oriented goal. On the other hand, it is possible to pose an externally-oriented goal for behavior which provides a negative feeling state but which leads to the usage of cognitive means which are optimal and thus which engender a feeling state so positive so as to overcome the negative feeling resulting from the consideration of the externally-oriented goal. Feelings always designate internally-oriented goals and they often designate externally-oriented goals. In addition, there are different types of positive and negative feelings -- i.e., feelings differ in degree and type. A difficult task within this framework is then the determination of how to "read" feelings correctly so that, regardless of the feeling being manifested, one would know what type of cognitive activity should occur to effect some optimal form of brain stimulation. As an illustration of this theory, the positive and negative feeling states associated with left and right brain hemispheric functioning will be discussed after a brief review of some of the features of left and right brain hemispheric activities.

Cognition and the Brain Hemispheres

The human brain is a large bilaterally symmetric organ that has a wrinkled surface which contains billions of brain cells termed neurons and their interconnections termed synapses. The outer surface of the brain with its large surface

area is called the cortex. The convolutions of the cortex constitute a phylogenetically recent adaptation making more surface area available and thus more neurons. Human brains have more neurons than all other mammalian brains except for possibly whale brains.

The human cortex is divided into a left hemisphere and a right hemisphere interconnected by a large bundle of fibers called the corpus callosum. Each hemisphere is subdivided into four lobes: the frontal, parietal, temporal, and occipital lobes. The frontal lobe is located in the front of the cortex and regulates motor activities (muscular contractions) as well as reasoning. The parietal lobe is located near the top and rear of the cortex and regulates the awareness of bodily processes and the integration of sensory stimulation. The occipital lobe is located in the back of the cortex and regulates vision. The temporal lobe is located near the center and bottom of the cortex and regulates hearing.

The lobes regulate different cognitive functions which exemplifies how psychological functions are localized in the brain. In addition, different functions are localized in the different hemispheres; such hemispheric localization is termed lateralization. In general, higher mammals evidence more cortical localization and lateralization than lower mammals. However, human brains are quite redundant in that the functions of certain cortical regions which may be destroyed can often be taken over by other intact cortical regions. One interesting property of the hemispheres is termed hemisphericity, the tendency of one hemisphere to dominate in the processing of information for each individual.

The two hemispheres constitute two different, independent, powerful systems of processing information. The left hemisphere regulates language production, speech, writing, calculation, and sequential and analytic thinking. The left hemisphere tends to dominate in most people and is most used during conscious, awake periods. It is especially suited to process information that is time-ordered and serially (successively or sequentially) presented. In general, the left hemisphere tends to be used when one is involved in the consolidation of one's environment.

The right hemisphere regulates visual-spatial thinking, imagination, holistic reasoning, facial recongition, recognition of novel melodies, and gestalt (or synthetic) thinking. The right hemisphere is the seat of unconscious thinking and is used extensively in dream states and when left hemispheric processing is insufficient to solve certain problems. It is especially suited to process information that is time-dependent and simultaneously presented. In general, the right hemisphere tends to be used when one is involved in the expansion of one's environment.

The left hemisphere tends to be used in dealing with familiar environments and the right hemisphere tends to be used in dealing with unfamiliar environments. These assertions are based on a study by Bever and Chiarello (1974) in which musically-experienced listeners were found to recognize simple melodies better in their right ears and thus with their left hemispheres and musically-naive listeners were found to recognize simple melodies better with their right hemispheres. As familiarity with some phenomena increases, so the left hemisphere becomes increasingly involved in the processing of the phenomena.

Affect and the Brain Hemispheres

Recent neurological research has established that different emotional reactions follow damage to the left and right hemispheres (Gaschwind, 1979). Lesions in the left hemisphere result in feelings of loss. Patients with such lesions are often disturbed by these disabilities and are often quite depressed. Comparable lesions in the right hemisphere do not have such emotional consequences. According to Guido Gainotti (1972) of the Catholic University of Rome, damage to the right hemisphere can result in an inability to discern emotion in others, whether the emotions are expressed in the form of spoken statements or facial expressions.

With that research as a preface, let me make the strong assertion that affect is, to a great extent, lateralized. In other words, several affective states are localized in the left hemisphere and several affective states are localized in the right hemisphere. These affective states include positive and negative ones which

indicate effective and ineffective utilization respectively of cognitive processes localized in one of the two hemispheres. Both types of affective states can suggest utilization of other cognitive processes. There are also negative affective states resulting from over-utilization of cognitive processes localized in one of the two hemispheres.

The feelings associated with modest utilization of left-hemispheric cognitive processes include the following: 1) positive feelings of mastery, success, competence, achievement, and control, and 2) negative feelings of failure, incompetence, and frustration. The negative feelings resulting from over-utilization of left-hemispheric cognitive processes include boredom, apathy, triviality, and despondency.

The feelings associated with modest utilization of right-hemispheric cognitive processes include the following: 1) positive feelings of awe, surprise, amazement, and discovery, and 2) negative feelings of confusion, perplexity, and dissonance. The negative feelings resulting from over-utilization of right-hemispheric cognitive processes include anxiety, instability, uncertainty, disorder, and chaos. Table 1 provides a characterization of how cognition is related to affect in the two hemispheres.

The positive feelings associated with the left hemisphere emanate from successful adaptation to familiar environments and from consolidation of one's situation in such environments. The complementary negative feelings emanate from an inability to adapt successfully to such familiar environments with their familiar problems. Over-utilization of left-hemispheric cognitive processes can result in additional negative feelings. If left-hemispheric cognitive processes have been used in a consistently effective manner and a chain of feelings of mastery and competence have resulted, then a threshold can be passed with successive successes such that positive feelings of mastery and competence are replaced by negative feelings of boredom, apathy, and triviality. Such feelings suggest that one's environment needs to be expanded and that right-hemispheric cognitive processes need to be elicited. If left-hemispheric cognitive processes have been used in a consistently effective

manner and a chain of feelings of failure and incompetence have resulted, then a threshold can be passed with successive failures such that negative feelings of failure and incompetence are replaced by even stronger negative feelings of despondency and depression.

The positive feelings associated with the right hemisphere emanate from exposure to novelty and new phenomena and from a successful expansion of one's environment. The complementary negative feelings emanate from an inability to adapt to novelty and a premature attempt to assimilate new phenomena. Over-utilization of right-hemispheric cognitive processes can result in additional negative feelings. If right-hemispheric cognitive feelings have been used in a consistently effective manner and a chain of feelings of awe and wonderment have resulted, then a threshold can be passed with successive discoveries such that positive feelings of awe and wonderment are replaced by negative feelings of detachment, listlessness, and being overwhelmed. Such feelings can interfere with adaptation to mundane matters and suggest that one's environment needs to be consolidated and that left-hemispheric cognitive processes need to be elicited. If right-hemispheric cognitive processes have been used in a consistently ineffective manner and a chain of feelings of confusion and perplexity have resulted, then a threshold can be passed with successive unresolved conflicts such that negative feelings of confusion and perplexity are replaced by more intense negative feelings of disorder, instability, uncertainty, and chaos.

Revisiting Theories of Intrinsic Motivation

One consequence of the theory presented is to reinterpret existing psychological theories. One such body of psychological theories relates to the study of motivation. One theory of motivation is directed at extrinsic motivation which suggests that certain external stimuli can serve as reinforcers which control the incidence of certain responses (e.g., Skinner, 1953). Weiner (1972) called a theory of motivation such as Skinner's a mechanistic one in that behavior is explained in

terms of stimulus-response connection and that intervening hypothetical constructs or actual internal processes are not employed in the analysis of actions. To interpret a theory of extrinsic motivation with the presented theory relating cognition and affect, one would have to describe the type of brain stimulation each reinforcer provides in order to account for why a reinforcer is a reinforcer on neurological and developmental grounds. Such a task is indeed formidable and eclipses the scope of this modest paper. In addition, it is most likely premature to offer such an expansive explanation.

Theories of intrinsic motivation are, however, more amenable to reinterpretation with the use of this theory of cognition and affect. There is a family of theories of intrinsic motivation which tend to be quite popular in contemporary educational psychology and which relate to stimulation of the left hemisphere and to modest utilization of left-hemispheric cognitive processes. These theories include the following: 1) the theory of competence motivation of Robert White (1959) which holds that there is a basic need to deal competently with the environment, and 2) the theory of achievement motivation of David McClelland (1955) which holds that there is a basic need to achieve which entails a standard of evaluation and a positive feeling associated with an achievement satisfying the standard. One prominent theory of contemporary student learning which emphasizes the motivating quality of achievement and mastery resulting from involvement with carefully preplanned learning sequences is the model of Mastery Learning (e.g., Bloom, 1976). Mastery learning, precision teaching, programmed instruction, and other related approaches to educational practice are to be termed "left-hemispheric" and are based, in part, on "left-hemispheric" theories of intrinsic motivation.

Other theories of intrinsic motivation relate to stimulation of the right hemisphere and to modest utilization of right-hemispheric cognitive processes. These theories include the following: 1) the theory of cognitive dissonance of Leon Festinger (1957) which holds that there is a basic need to resolve a dissonance or conflict between any two situations, ideas, persons, or combination thereof and

2) the theory of epistemic motivation of David Berlyne (1965) which holds that there is a basic need to reduce a conceptual conflict by learning something. To Festinger, a cognitive dissonance can be resolved by modifying one's ideas, by altering the conditions of the dissonance, by modifying one's interpretation of the dissonance, or by persuading others to modify their views. To Berlyne, a conceptual conflict can be resolved through obtaining new knowledge or by formulating a new perspective. One theory of student learning which emphasizes the motivating quality of discovery and insight resulting from resolving conflict and seeking new phenomena and relationships through inductive reasoning and other investigative procedures is discovery learning (e.g., Bruner, 1966). Discovery learning, creativity training, and other related approaches to educational practices including many Piagetian educational practices are to be termed "right-hemispheric" and are based, in part, on "right-hemispheric" theories of intrinsic motivation.

Conclusion

Let me suggest that this theory relating cognition and affect may by used to help teachers monitor the feelings of their students and to help students monitor their own feelings is such a way that they can regulate their own feelings as they continue their cognitive development and education. This theory is offered as a foundation for a general theory of cognition and affect which is meant to coordinate contemporary ideas on meta-cognition (e.g., Brown, 1978) and on self-regulation (e.g., Mahoney, 1979) with a consideration of neuroscience and education. However, enough has been described to offer empirical investigation -- e.g., testing the hypothesis that the preference to use cognitive processes localized in one hemisphere is related to the preference to experience positive feelings localized in that hemisphere more than positive feelings localized in the other hemisphere and to the preference not to experience negative feelings localized in that hemisphere more than negative feelings localized in the other hemisphere.

This theory needs to be extended, because the repertoire of cognitive processes available to an individual is directly related to the range of positive and negative feelings that the individual can experience and, thus far, only an inventory of some of the cognitive processes and feelings available to an individual has been made. As one grows in intelligence, one can grow in one's range of feelings, and a task then for further research regarding this theory is a more complete cognitive taxonomy of feelings which includes neurological findings regarding stimulation to the reptilian complex, the limbic system, as well as the neocortex (MacLean, 1973).

This speculative paper has drawn more heavily on neuroscience than on developmental psychology, but both will most likely be needed to develop a general theory of cognition and affect that will suggest educational and other applications.

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Table 1

A Characterization of the Dynamics underlying Cognition and Affect